Conditioning for Load Carriage across the Career: Green, Blue, and Red

Orr, Rob Marc

2020 NSCA TACTICAL ANNUAL TRAINING

AUGUST 25 – 28

#NSCATactical20

CONFLICT OF INTEREST STATEMENT

I have no actual or potential conflict of interest in relation to this presentation.

Conditioning for Load Carriage across the Career: Green, Blue, and Red

Dr Rob Orr

PhD, PHTY, BFET, TSAC-F, ADFPTI, TSAC-F*D

Content

- Loads Carried and their contexts
- Impacts of loads carried
- Conditioning for load carriage
- Rehabilitation post load carriage injury

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HISTORICAL CONTEXT

https://www.pinterest.com.au/pin/430867889327140531/

- From the early Assyrian spearman of antiquity (circa 800 B.C.), soldiers have been required to carry external loads consisting of weaponry, equipment and food

Orr, R. (2010). The History of the Soldier's Load, Australian Army Journal, Vol vii(2), pp. 67-88.

Knapik, J., & Reynolds, K. (2012). Chapter 11: Load carriage in military operations: a review of historical, physiological, biomechanical and medical aspects. In Military Quantitative Physiology: Problems and Concepts in Military Operational Medicine (pp. 303-337). Maryland, USA: Borden Institute..

- Downstream effects of these loads have been shown to impact on the tactics of warfare, cause injury and reduce fighting force size

Lothian, N. V. (1921). The load carried by the soldier. J R Army Med Corps, 38, 9-24, 241-263, 342 - 351, 448-458

Lee, J. W. I. (2007). *A Greek Army on the March: Soldiers and Survival in Xenophon's Anabasis*. New York: Cambridge University Press.

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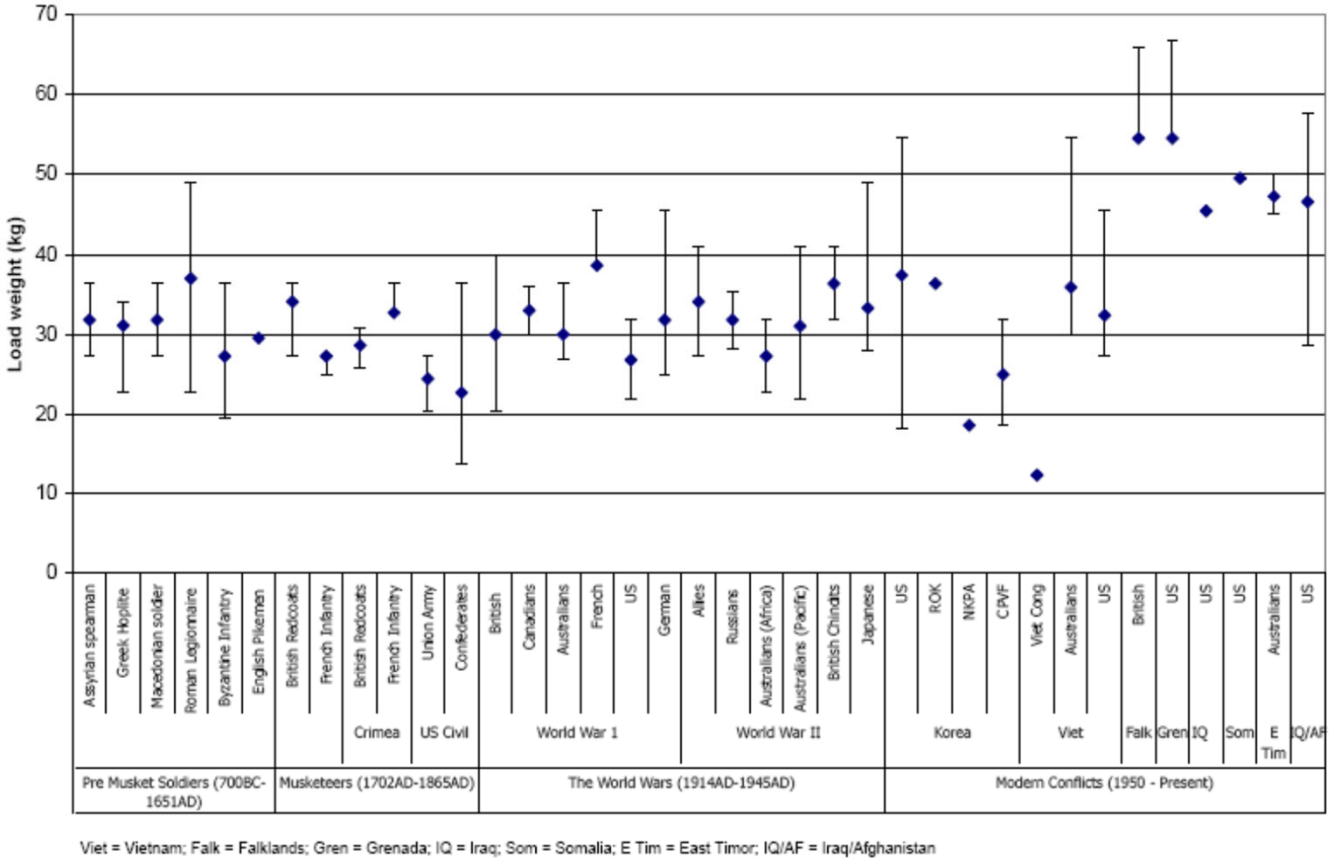

Viet = Vietnam; Falk = Falklands; Gren = Grenada; IQ = Iraq; Som = Somalia; E Tim = East Timor; IQ/AF = Iraq/Afghanistan

Orr, R. (2010). The History of the Soldier's Load, Australian Army Journal, Vol vii(2), pp. 67-88.

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CURRENT CONTEXT

- PO loads
  - M=28.4 ± 10.0 kg
- MO loads
  - M=56.7 ± 15.3 kg
- OVERALL loads
    - 47.7±21.0 kg,

Orr, R. M., Pope, R., Coyle, J., & Johnston, V. (2015). Occupational Loads Carried by Australian Soldiers on Military Operations. Journal of Health Safety and the Environment, 31(1), 451-467.

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CURRENT CONTEXT

- Currently lighter soldiers carry the same absolute loads as heavier soldiers but heavier relative loads

ABSOLUTE LOADS	*RELATIVE LOADS*
Light 20%: *M* = 34.7 kg	Light 20%: *M* = 49%
Heavy 20%: *M* = 35.7 kg	Heavy 20%: *M* = 36%
p=.902	**p=.0509**

Orr, R. M., Pope, R., Coyle, J., & Johnston, V. (2015). Occupational Loads Carried by Australian Soldiers on Military Operations. Journal of Health Safety and the Environment, 31(1), 451-467.

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HISTORICAL CONTEXT

http://2.bp.blogspot.com/-xHtSiLRFIMQ/UfewLRnEgAI/AAAAAAAAIpc/54yapn_ibtE/s1600/Curious+Black+&+White+Photographs+of+The+Police+Officers+from+1890–1930+(28).jpg

http://img.dailymail.co.uk/i/pix/2008/04_03/TabGunGirlLEWIS_468x715.jpg

https://www.dailymail.co.uk/femail/article-6490555/Where-arrested-Three-young-female-police-officers-set-internet-alight.html

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CURRENT CONTEXT

ILAV type (A-C) & Normal station wear (N)	ILAV Weight (kg)	Duty load Complete (kg)	Total load including officer weight (kg)
A	4.12 ± 0.65*	11.53 ± 0.77‡	88.03 ± 20.49
B	3.54 ± 0.70*	11.01 ± 1.01‡	87.51 ± 20.60
C	3.24 ± 0.48*	10.77 ± 1.16‡	87.27 ± 20.66
N	NA	8.69 ± 0.68	85.19 ± 20.24

Orr, R. M., Pope, R., Schram, B., Lyons, K., Correa, D., Tomes, C., & Hing, W. (2017). Individual Light Armour Vest (ILAV) Technical Report

* Significantly different ($p<0.05$) between vests: ‡ Significantly different ($p<0.001$) from normal station wear

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CURRENT CONTEXT

	FEMALE	MALE	FEMALE	MALE
ILAV type	**ILAV + Duty Loads (kg)**	**ILAV + Duty Loads (kg)**	**%BW**	**%BW**
A	11.14	11.85	16.90	14.90
B	10.80	11.18	16.43	13.91
C	10.24	11.22	15.60	13.95
N	8.68	8.70	13.20	10.92
	*p=0.225		*p=0.009	

Orr, R. M., Pope, R., Schram, B., Lyons, K., Correa, D., Tomes, C., & Hing, W. (2017). Individual Light Armour Vest (ILAV) Technical Report

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CURRENT CONTEXT

	COMBINED (n=246)
Age (yrs)	30.82±5.84
Years sworn (yrs)	3.62±3.46
Body Wt (Kg)	85.69±15.08
Load Wt (Kg)	**10.72±1.73**
Relative load (%)	**11.83±2.38**

Baran, K. Dulla, J., Orr, R., Dawes, J. & Pope, R. (2018). Duty loads carried by the LA Sheriff's Department Officers Journal of Australian Strength and Conditioning, 26(5), 34-38.

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CURRENT CONTEXT

	FEMALE (n=43)	MALE (n=203)
Age (yrs)	30.60±4.56	30.86±6.09
Years sworn (yrs)	4.03±2.92	3.54±3.56
Body Wt (Kg)	68.78±10.96*	89.27±13.31
Load Wt (Kg)	**9.99±1.66***	**10.87±1.71**
Relative load (%)	**13.36±2.46***	**11.50±2.24**

* Significantly different from male sheriffs, p<.001

Baran, K. Dulla, J., Orr, R., Dawes, J. & Pope, R. (2018). Duty loads carried by the LA Sheriff's Department Officers Journal of Australian Strength and Conditioning, 26(5), 34-38.

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CURRENT CONTEXT

(Dawes, Kornhauser, Holmes, et al., submitted)

	Cohort Mean ± SD (Range)	Male Mean ± SD (Range)	Female Mean ± SD (Range)
Age (years)	38.79 ± 7.97 (22 – 66)	38.36 ± 8.06 (22-66)	40.88 ± 7.68 (25-50)
Height (cm)	177.45 ± 8.36 (156.21 – 195.58)	179.53 ± 6.95 (165.10 – 195.58)	167.32 ± 7.49 (156.21 – 177.80)
Weight (kg)	88.61 ± 19.44 (51.71 – 154.59)	91.35 ± 18.20 (66.04 – 154.58)	75.22 ± 20.95 (51.71 – 118.16)
Absolute load (kg)	**9.57 ± .94** (7.08 – 12.02)	**9.61 ± .97** (7.08 – 12.02)	**9.34 ± .81** (8.26 – 10.70)
Relative load (% of body weight)	**11.19 ± 2.14** (5.93 – 17.02)	**10.82 ± 1.87** (5.93 – 14.56)	**13.00 ± 2.56** (8.41 – 17.02)

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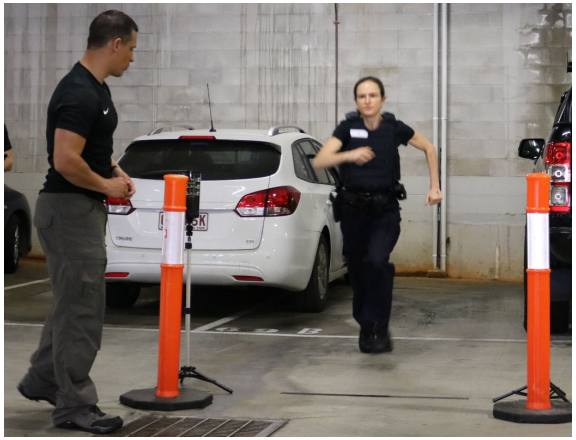

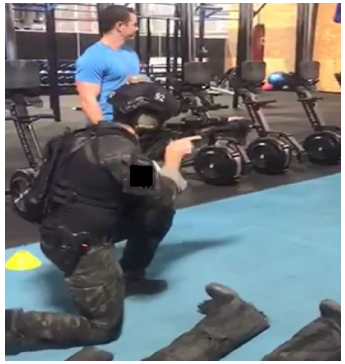

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Dr Rob Orr, PhD, MPHTY, BFET, ADFPTI, TSAC-F*D

Conditioning for Load Carriage across the Career: Green, Blue, and Red

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HISTORICAL CONTEXT

1770

1879

2016

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CURRENT CONTEXT

	MEAN ± SD
Age (yrs)	34.14 ± 7.69
Years of Experience (yrs)	7.00 ± 8.18
Unloaded Weight (kg)	90.96 ± 9.65
Weight of Supervisor PPE (kg)	**11.03 ± 0.10**
Weight of Firefight PPE-FF (kg)	**22.61 ± 0.31**
Relative Weight of PPE (% body weight)	**13.13 ± 0.05**
Relative Weight of PPE-FF (% body weight)	**22.23 ± 2.18**

Walker, A., Pope, R., Schram, B., Gorey, R., & Orr, R. (2019). The Impact of Occupational Tasks on Firefighter Hydration During a Live Structural Fire. Safety, 5(2), 36. Retrieved from https://www.mdpi.com/2313-576X/5/2/36

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CURRENT CONTEXT

(Dawes et al., unpublished)

Position	Driver	Firefighter	Officer	Paramedic
Age (yrs)	41.89 ±8.22	35.63 ± 8.67	49.85 ± 6.48	39.00 ± 10.24
Height (cm)	175.61± 8.73	178.17 ± 6.12	176.39 ± 4.86	178.16 ± 4.65
Weight (kgs)	93.01± 16.16	87.55 ± 12.17	90.50± 15.16	88.45 ± 10.35
BMI	30.15 ± 4.41	27.49 ± 3.17	28.59 ± 4.22	27.82 ± 2.74
PPE Load (kgs)	**27.25 ±6.27**	**27.99 ± 1.92**	**27.00± 2.01**	**28.02 ± 2.177**
PPE Load (%bw)	**30.49 ± 10.46**	**32.57 ± 4.99**	**30.40 ± 4.58**	**32.10 ± 4.67**

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CURRENT CONTEXT

http://bloximages.newyork1.vip.townnews.com/estesparknews.com/content/tncms/assets/v3/editorial/d/c7/dc7f6316

http://www.medicinec.si/wp-content/uploads/2013/10/imgS1351803309img5092e1ada9b3c.jpg

http://www.sandia.gov/news-center/news-releases/2004/images/SAR-map.gif

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RISKS ASSOCIATED WITH LOAD CARRIAGE

- Injuries: Associated with a variety of injuries (from skin blistering to muscle, ligament, tendon, bone and nervous system injuries)

Orr, R., Pope, R., Johnston, V. & Coyle, J. (2014). Reported Load Carriage Injuries: An Australian Army Soldier Profile, Journal of Occupational Rehabilitation, 25:316–322

Orr. R., Pope, R., Coyle, J. & Johnston, V. (2016). Self-reported load carriage injuries in Australian Regular Army soldiers, International Journal of Injury Control and Safety Promotion, pp. 1-9 http://dx.doi.org/10.1080/17457300.2015.1132731

Knapik, J., Reynolds, K., Orr, R. & Pope,R (2016). Load Carriage–Related Paresthesias: Part 1: Rucksack Palsy and Digitalgia Paresthetica, Journal of Special Operations Medicine, 15 (4), 37-42

Orr, R. & Pope, R. (2016) Gender Differences in Load Carriage Injuries of Australian Army Soldiers, BMC Musculoskeletal Disorders, 17 (488), pp. 1-8. DOI 10.1186/s12891-016-1340-0

Knapik, J., Reynolds, K., Orr, R. & Pope,R (2017). Load Carriage–Related Paresthesias: Part 2 Meralgia, Journal of Special Operations Medicine, 17(1) pp. 25-31.

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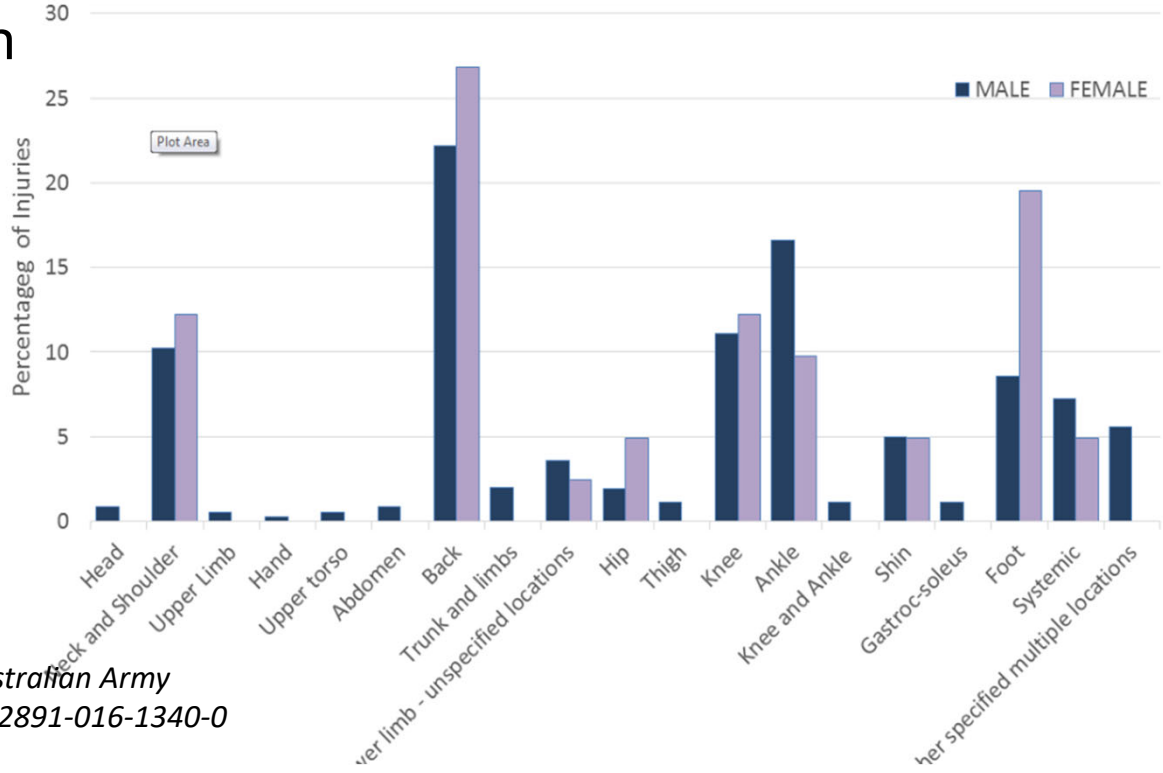
RISKS ASSOCIATED WITH LOAD CARRIAGE

- Some differences may exist between genders



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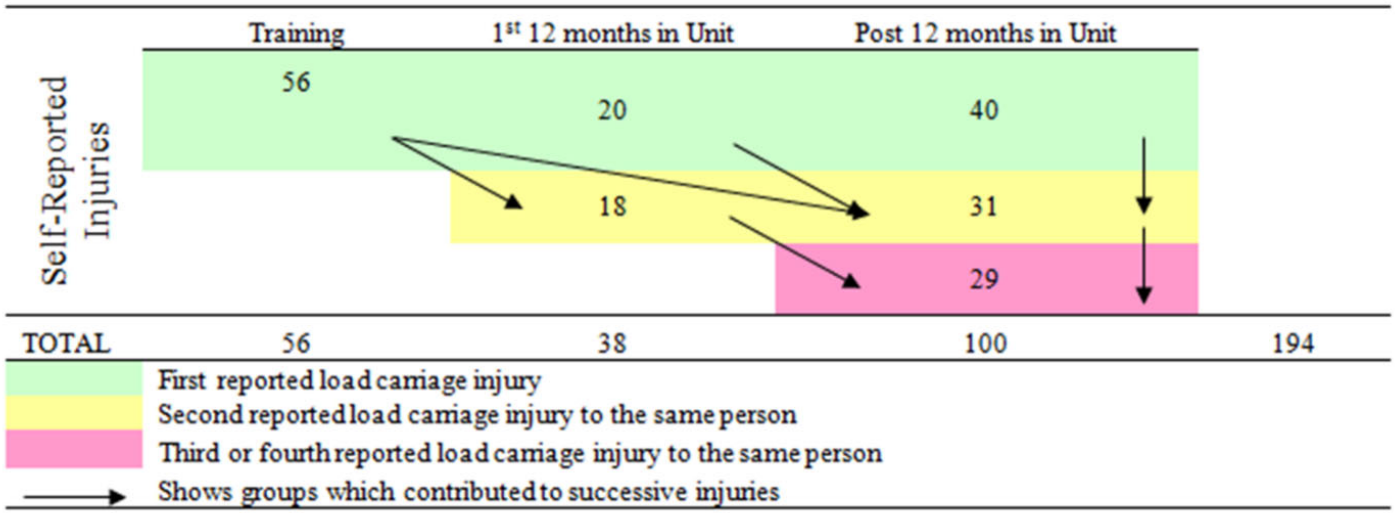
RISKS ASSOCIATED WITH LOAD CARRIAGE

- Once injured – more likely to be reinjured



Orr. R., Pope, R., Coyle, J. & Johnston, V. (2016). Self-reported load carriage injuries in Australian Regular Army soldiers, International Journal of Injury Control and Safety Promotion, pp. 1-9 http://dx.doi.org/10.1080/17457300.2015.1132731

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RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
  - ↓ Mobility
    - Increased risk of trip and fall
    - Decrease in CODS with loads of 10kg

Orr, R., Kukić, F., Cvorovic, A., Koropanovski, N., Janković, R., Dawes, J., & Lockie, R. (2019). Associations between Fitness Measures and Change of Direction Speeds with and without Occupational Loads in Female Police Officers. International journal of environmental research and public health, 16(1947). doi:doi:10.3390/ijerph16111947

Joseph, A., Wiley, A., Orr, R., Schram, B. & Dawes, J. (2018) The Impact of Added Load on Measures of Power and Agility in Tactical Occupations: A Critical Review Int. J. Environ. Res. Public Health 15(1), 88; doi: 10.3390/ijerph15010088

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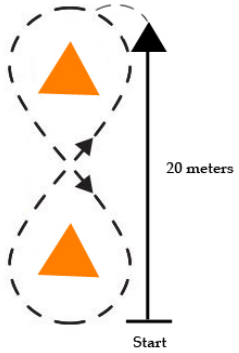

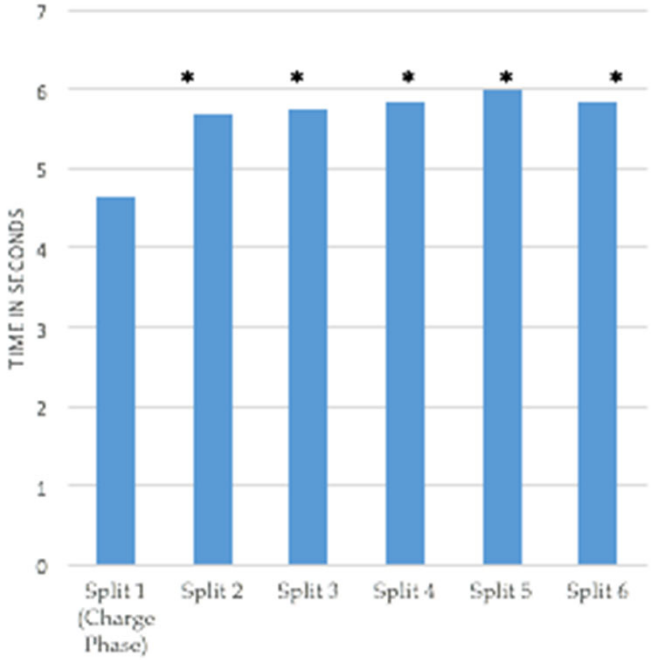

Joseph, A., Wiley, A., Orr, R., Schram, B. & Dawes, J. (2018) The Impact of Added Load on Measures of Power and Agility in Tactical Occupations: A Critical Review Int. J. Environ. Res. Public Health 15(1), 88; doi: 10.3390/ijerph15010088

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RISKS ASSOCIATED WITH LOAD CARRIAGE

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    - Decrease in CODS with loads of 10kg

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2019
Australian Tactical Medicine Conference
Brisbane QLD | Sep 19 & 20

RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
  - ↓ Mobility
    - Increased risk of trip and fall
    - Decrease in CODS
    - Decreased ability to negotiate escape routes

RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
  - ↓ Mobility
    - Increased risk of trip and fall
    - Decreased ability to negotiate escape routes

		Under 25% BW	Over 25% BW
Dummy drag	10m sprint (sec)	2.48 ± 0.13	2.43 ± 0.20
	10m dummy drag (sec)	6.27 ± 0.73	7.32 ± 0.44
	Total time (sec)	10.75 ± 0.60	09.74 ± 0.60

Carlton, S.D., Carbone, P.D., Stierli, M & Orr, R. (2014). The Impact of Occupational Load Carriage on the Mobility of the Tactical Police Officer. J. Aust. Strength Cond., 22(1), pp. 32-37.

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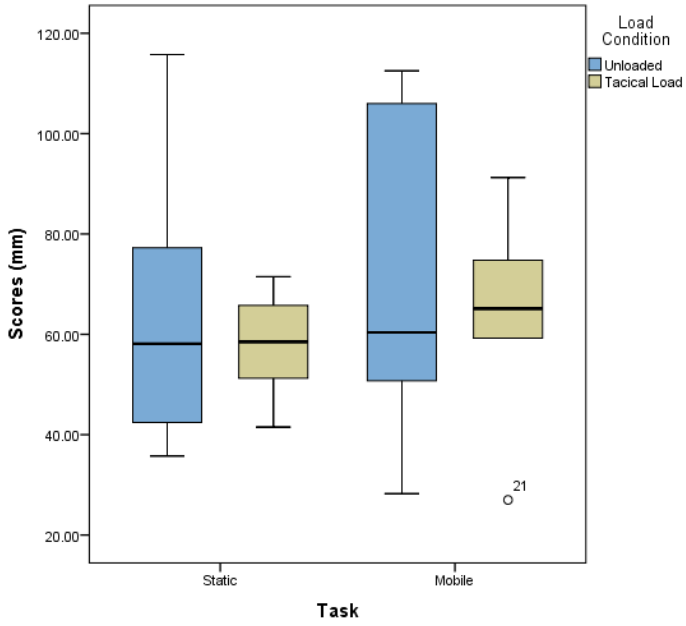
RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
  - ↓ Lethality

Knapik, J. J., Staab, J., Bahrke, M., Reynolds, K. L., Vogel, J. A., & O'Connor, J. (1991). Soldier performance and mood states following a strenuous road march. Mil Med, 156(4), 197-200.

Knapik, J. J., Ang, P., Meiselman, H., Johnson, W., Kirk, J., Bensel, C. K., & Hanlon, W. (1997). Soldier performance and strenuous road marching: influence of load mass and load distribution. Mil Med, 162(1), 62-67

Rice, V. J., Sharp, M., Tharion, W. J., & Williamson, T. (1999). Effects of a Shoulder Harness on Litter Carriage Performance and Post-Carry Fatigue of Men and Women. Military Performance Division. US Army Research Institute of Environmental Medicine, Natick, 76.



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RISK ENHANCING FACTORS

- ↑ in load weight = ↑ in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running
- ↑ in speed of load carriage = ↑ in the energy cost of carrying given load (more than weight)?
  ↑ *0.5km/h= ↑10kg*

Drain, J., Orr, R. M., Attwells, R., & Billing, D. C. (2012). *Load Carriage Capacity of the Dismounted Combatant - A Commander's Guide Technical Report DSTO-TR-2765*.

RISK ENHANCING FACTORS

- ↑ in gradient of load carriage = ↑ in the energy cost of carrying given load (more than weight)? ↑ *1%= ↑10kg*

Drain, J., Orr, R. M., Attwells, R., & Billing, D. C. (2012). Load Carriage Capacity of the Dismounted Combatant - A Commander's Guide Technical Report DSTO-TR-2765.

http://mountainenterprise.com/fds/images/story/fs_4764.jpg

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RISK ENHANCING FACTORS

- Different terrains types will elicit different energy cost requirements

  (road-light brush-heavy brush-sand)

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RISK ENHANCING FACTORS

- Differences in load placement will elicit differences in energy cost.
  - Weight on the feet more costly than the back
  - Thigh more costly that back (0.5kg ↑ cost by 3.5%)
  - Shoulder more costly than back
  - Hands around 2 x more costly than back*

Drain, J., Orr, R. M., Attwells, R., & Billing, D. C. (2012). Load Carriage Capacity of the Dismounted Combatant - A Commander's Guide Technical Report DSTO-TR-2765.

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RISK ENHANCING FACTORS

- The cost of carrying a 7 kg load in the hands to be nearly twice that of carrying the load on the torso. Soule, R. G., & Goldman, R. F. (1969). Energy cost of loads carried on the head, hands, or feet. *J Appl Physiol, 27*(5), 687-690.
- A significantly higher ($p<.05$) cost of load carriage in the hands (mean of 6.96 KCAL/min) than on the back (mean of 5.27 KCAL/min).

Datta, S. R., & Ramanathan, N. L. (1971). Ergonomic comparison of Seven Modes of Carrying Loads on the Horizontal Plane. Ergonomics, 14(2), 269-278.

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RISK ENHANCING FACTORS

- Unilateral hand loading can:
  - Increase hip muscle activity to twice that for the same load carried bilaterally

    Neumann, D. A., Cook, T. M., Sholty, R. L., & Sobush, D. C. (1992). An electromyographical analysis of hip abductor muscle activity when subjects are carrying load in one or both hands. Phys Ther, 72(3), 207-217
  - cause gait asymmetry

    Zhang, X. A., Ye, M., & Wang, C. T. (2010). Effect of unilateral load carriage on postures and gait symmetry in ground reaction force during walking. Computer Methods in Biomechanics and Biomedical Engineering, 13(3), 339-344.
  - potentially increase further energy expenditure

    Datta, S. R., & Ramanathan, N. L. (1971). Ergonomic comparison of Seven Modes of Carrying Loads on the Horizontal Plane. Ergonomics, 14(2), 269-

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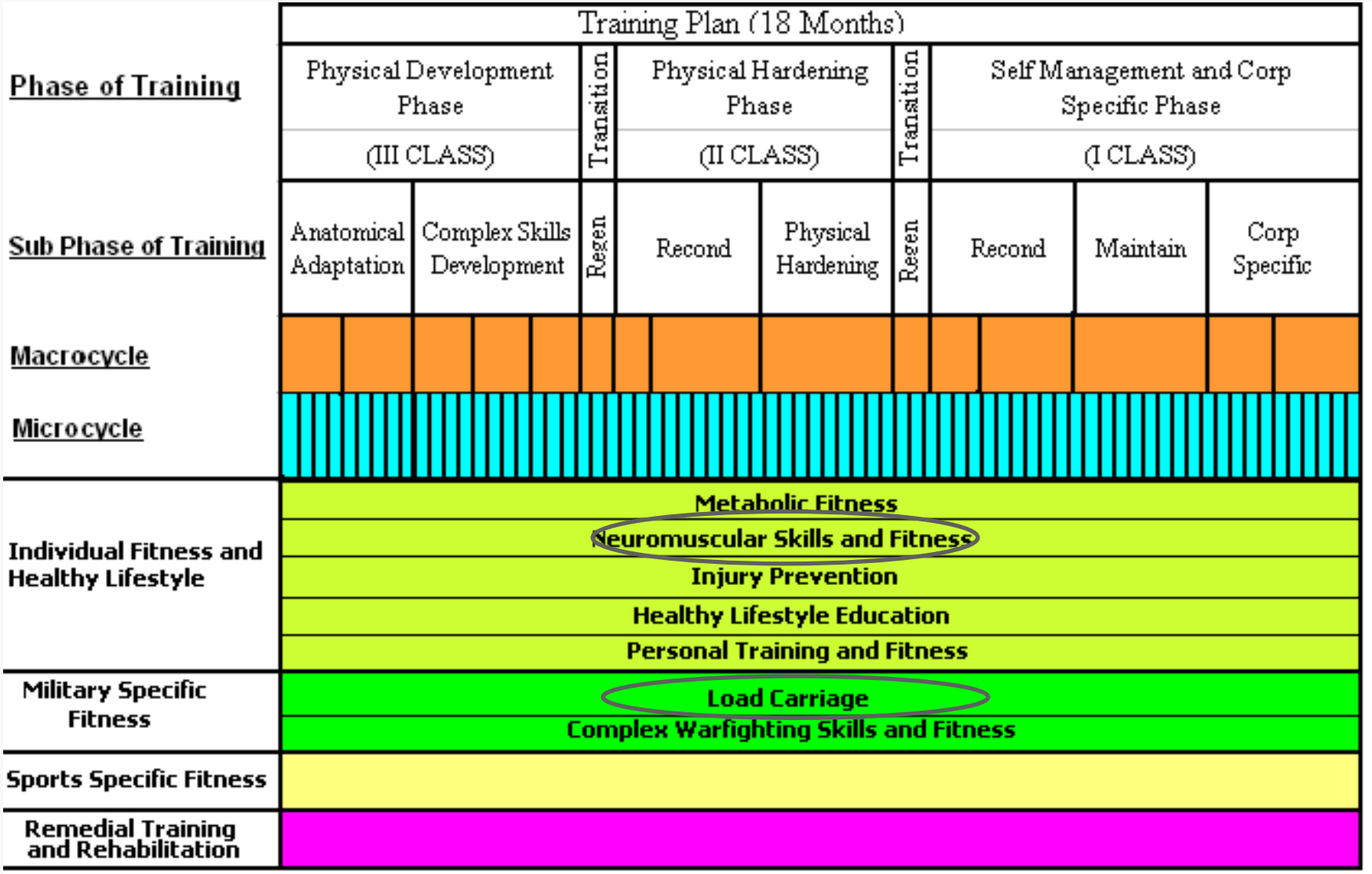
CONDITIONING FOR LOAD CARRIAGE

F.I.T.T Formula (Frequency, Intensity, Time & Type)

- F. 10-14 days per load carriage session
- I. To loads required (Last decade 40-50kg) at the speeds and over the terrains required
- T. Duration of load carriage operations
- T. Load carriage preferable, but combined resistance and cardio may be of some benefit

Orr, R., Pope, R., Johnston, V., & Coyle, J. (2010). Load carriage: Minimising soldier injuries through physical conditioning-A narrative review. Journal of military and veterans' health, 18(3), 31-38.

Knapik, J. J., Harman, E. A., Steelman, R. A., & Graham, B. S. (2012). A systematic review of the effects of physical training on load carriage performance. The Journal of Strength & Conditioning Research, 26(2), 585-597.


Training Plan (18 Months)
Phase of Training
Physical Development Phase
(III CLASS)
Transition
Physical Hardening Phase
(II CLASS)
Transition
Self Management and Corp Specific Phase
(I CLASS)
Sub Phase of Training
Anatomical Adaptation
Complex Skills Development
Regen
Record
Physical Hardening
Regen
Record
Maintain
Corp Specific
Macrocycle
Microcycle
Individual Fitness and Healthy Lifestyle
Metabolic Fitness
Neuromuscular Skills and Fitness
Injury Prevention
Healthy Lifestyle Education
Personal Training and Fitness
Military Specific Fitness
Load Carriage
Complex Warfighting Skills and Fitness
Sports Specific Fitness
Remedial Training and Rehabilitation


Training Plan (18 Months)
Phase of Training
Physical Development Phase
(III CLASS)
Transition
Physical Hardening Phase
(II CLASS)
Transition
Self Management and Corp Specific Phase
(I CLASS)
Sub Phase of Training
Anatomical Adaptation
Complex Skills Development
Regen
Recond
Physical Hardening
Regen
Recond
Maintain
Corp Specific
Load Carriage Continuum
Volume & Intensity
Volume
Intensity
Active Recovery
Vol & Int
Maint
Active Recovery
Int
Vol & Int
Dist
Load
Spd
30
47%
15
35%
11
15%
8
DPCU + F88
6
5.5
5
Ex SR
CFA
Capstone 1
2 4 6 8 10 12 14 16 18 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76
Neuromuscular Fitness
Teach Foundation Skills
Absolute Strength
Relative Strength
Intro Power
Active Recovery
Abs Str
Rel Str
Rel Str - End
Power
Active Recovery
Relative Strength
Maintain
Vol
Int
Hi
Med
Low
100
90
80
60
50
40
2 4 6 8 10 12 14 16 18 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76

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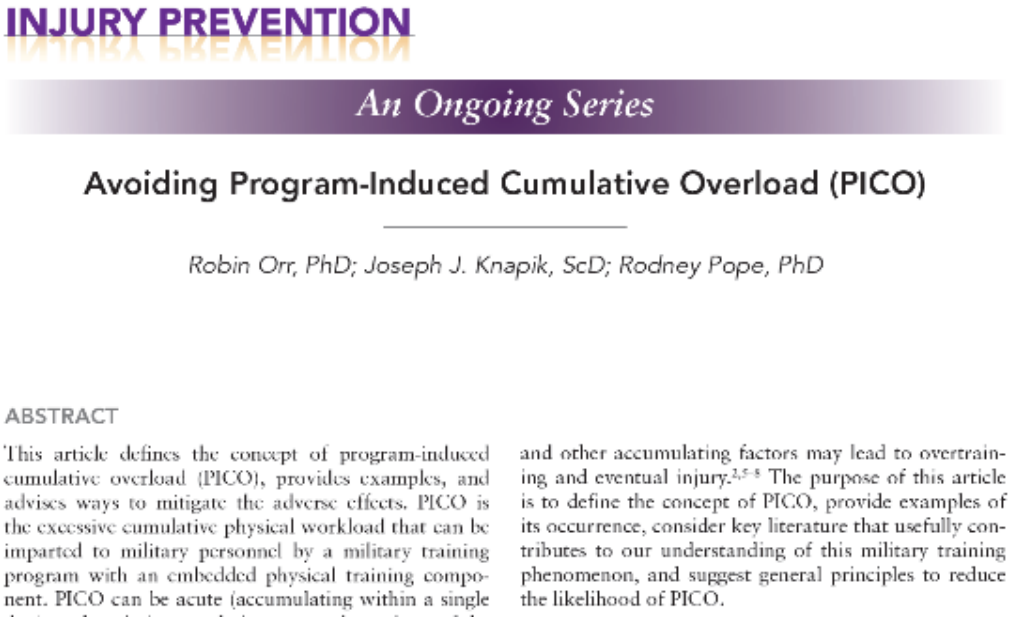
CONDITIONING FOR LOAD CARRIAGE

- Must continue complete work picture



INJURY PREVENTION

An Ongoing Series

Avoiding Program-Induced Cumulative Overload (PICO)

Robin Orr, PhD; Joseph J. Knapik, ScD; Rodney Pope, PhD

ABSTRACT

This article defines the concept of program-induced cumulative overload (PICO), provides examples, and advises ways to mitigate the adverse effects. PICO is the excessive cumulative physical workload that can be imparted to military personnel by a military training program with an embedded physical training component. PICO can be acute (accumulating within a single

and other accumulating factors may lead to overtraining and eventual injury.[3,5-8] The purpose of this article is to define the concept of PICO, provide examples of its occurrence, consider key literature that usefully contributes to our understanding of this military training phenomenon, and suggest general principles to reduce the likelihood of PICO.

Orr R, Knapik J, Pope R. Avoiding Program-Induced Cumulative Overload (PICO). Journal of Special Operations Medicine: A peer reviewed journal for SOF medical professionals 16(2):61-4, 2016.

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- Program Induced Cumulative Overload (PICO)
  - This is an unseen overload caused by the nature of the overarching training program
    - Includes additional kms/mi's covered marching around the area
    - Other physical activities (drill, weapons training, MUC)

April 20th & 21st
1200-400 PDT
THE TACTICAL LIFE
https://bit.ly/theTACTICALlife

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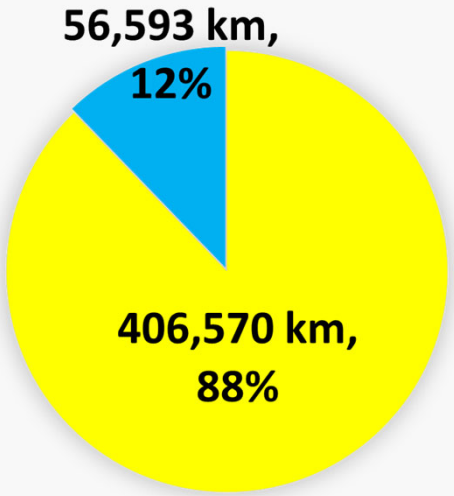
- Data triangulation
  - Observation of selected training days of the courses complemented the desktop analysis
  - GPS



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Measure	Pack March 1 (mins:sec)	Pack March 2 (mins:sec)	Pack March 3 (mins:sec)
Pack March 1 (mins:sec)	1	.840**	.815**
Pack March 2 (mins:sec)	.840**	1	.881**
Pack March 3 (mins:sec)	.815**	.881**	1
Shuttle Run (Level)	-.712**	-.709**	-.711**

Robinson, J., Roberts, A. Irving, S. & Orr., R. (2018). Aerobic fitness of greater importance than strength in load carriage performance. International Journal of Exercise Science 11(4): 987-998

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Measure	Pack March 1 (mins:sec)	Pack March 2 (mins:sec)	Pack March 3 (mins:sec)
1RM Bench Press (kg)	-.360*	-.318*	-.295*
Bench Ratio (%)	-.465**	-.365*	-.379**
1RM Squat (kg)	-.401**	-.335*	-.316*
Squat Ratio (%)	-.500**	-.381**	-.396**
1RM Deadlift (kg)	-.288*	-0.248	-0.215
Deadlift Ratio (%)	-.403**	-.294*	-.305*
1RM Pull-up (kg)	-.452**	-.439**	-.416**
Pull-up Ratio (%)	-.607**	-.512**	-.541**
Vertical Jump (cm)	-.501**	-.541**	-.523**
10 meter sprint	.373*	0.178	0.217

** Correlation is significant at the 0.01 level (2-tailed).

Robinson, J., Roberts, A. Irving, S. & Orr., R. (2018). Aerobic fitness of greater importance than strength in load carriage performance. International Journal of Exercise Science 11(4): 987-998

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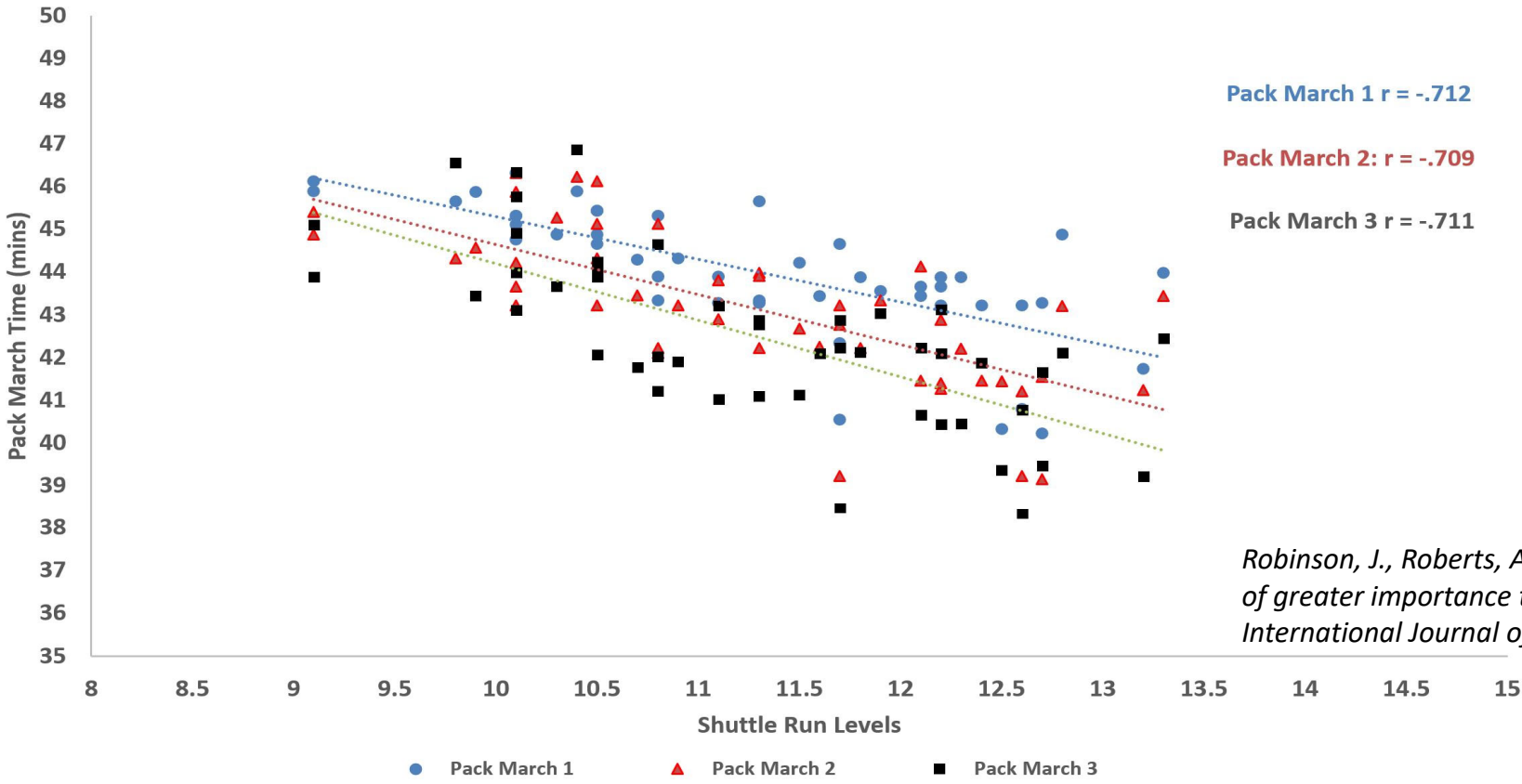

Pack March 1 r = -.712

Pack March 2: r = -.709

Pack March 3 r = -.711

Robinson, J., Roberts, A. Irving, S. & Orr., R. (2018). Aerobic fitness of greater importance than strength in load carriage performance. International Journal of Exercise Science 11(4): 987-998

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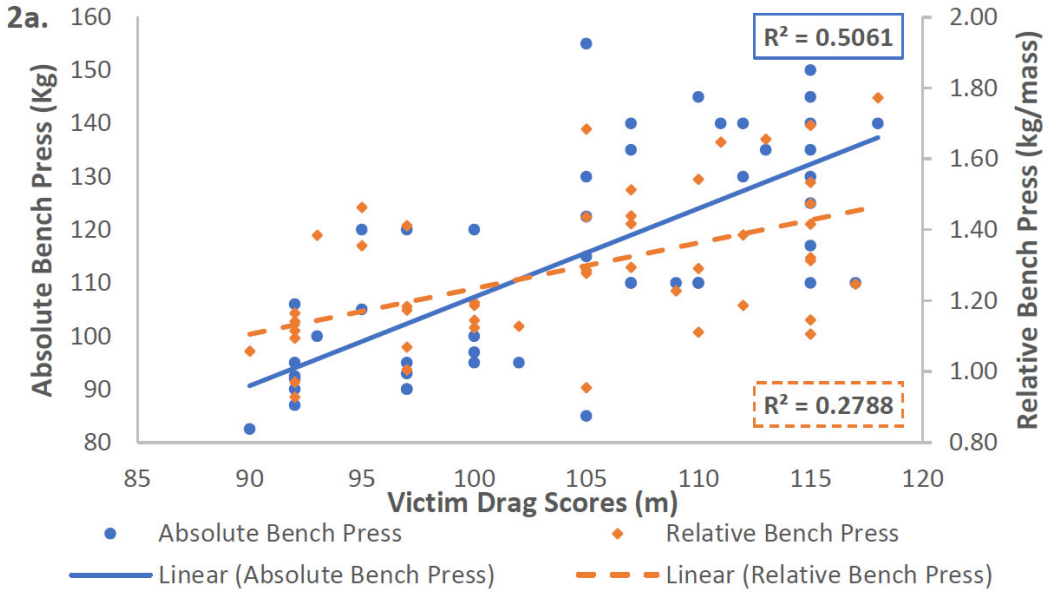

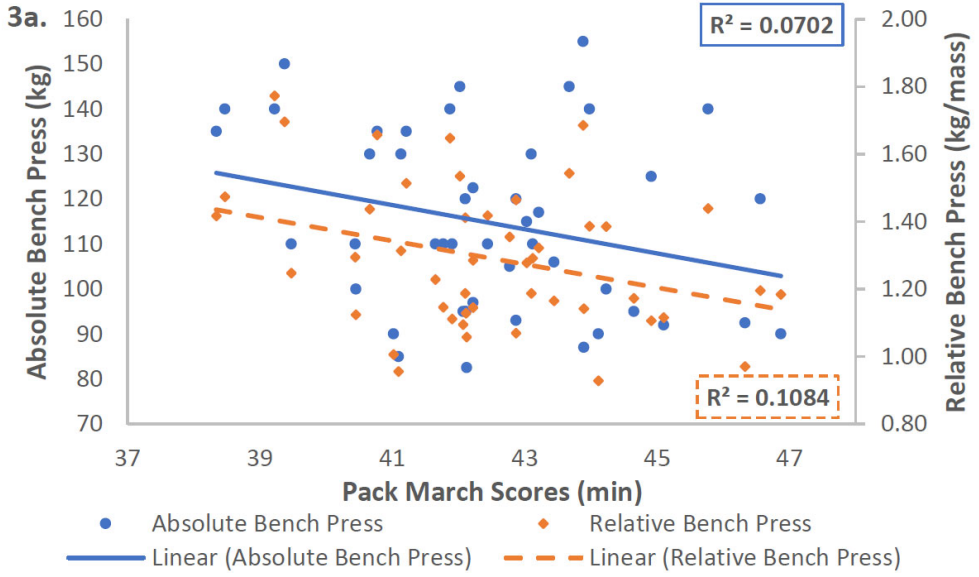

Orr., R., Robinson, J., Hasanki, K., Talaber, K., Schram, B. & Roberts, M. (2020) The Relationship between Strength Measures and Task Performance in Specialist Tactical Police. Journal of Strength and Conditioning Researchdoi: 10.1519/JSC.0000000000003511

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	Shuttle Run	Vertical Jump (cm)	Grip Strength (kg)	Leg Dyno (kg)
Static Score	0.528**	0.322	-0.001	0.343
Dynamic Scenario	0.170	-0.022	-0.367*	-0.069
Positive ID Scenario	0.009	0.221	0.040	0.344*
Scenario Combined	0.062	0.181	-0.153	0.286
Total Score	0.220	0.255	-0.129	0.350*

Muirhead, H., Orr, R.M., Schram, B., Kornhauser, C., Holmes, R. & Dawes, J.J. (2019). The Relationship between Fitness and Marksmanship in Police Officers. Safety 5(3), 54; https://doi.org/10.3390/safety5030054 (registering DOI)

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	Static Score	Dynamic Scenario	Positive Identification Scenario
Static Score	-	0.314	0.281
Dynamic Scenario	0.314	-	0.177
Positive Identification Scenario	0.281	0.177	-

Muirhead, H., Orr, R.M., Schram, B., Kornhauser, C., Holmes, R. & Dawes, J.J. (2019). The Relationship between Fitness and Marksmanship in Police Officers. Safety 5(3), 54; https://doi.org/10.3390/safety5030054 (registering DOI)

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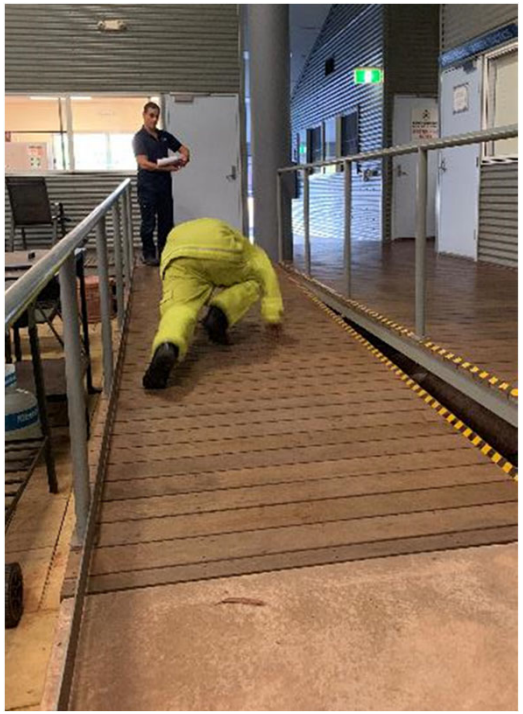

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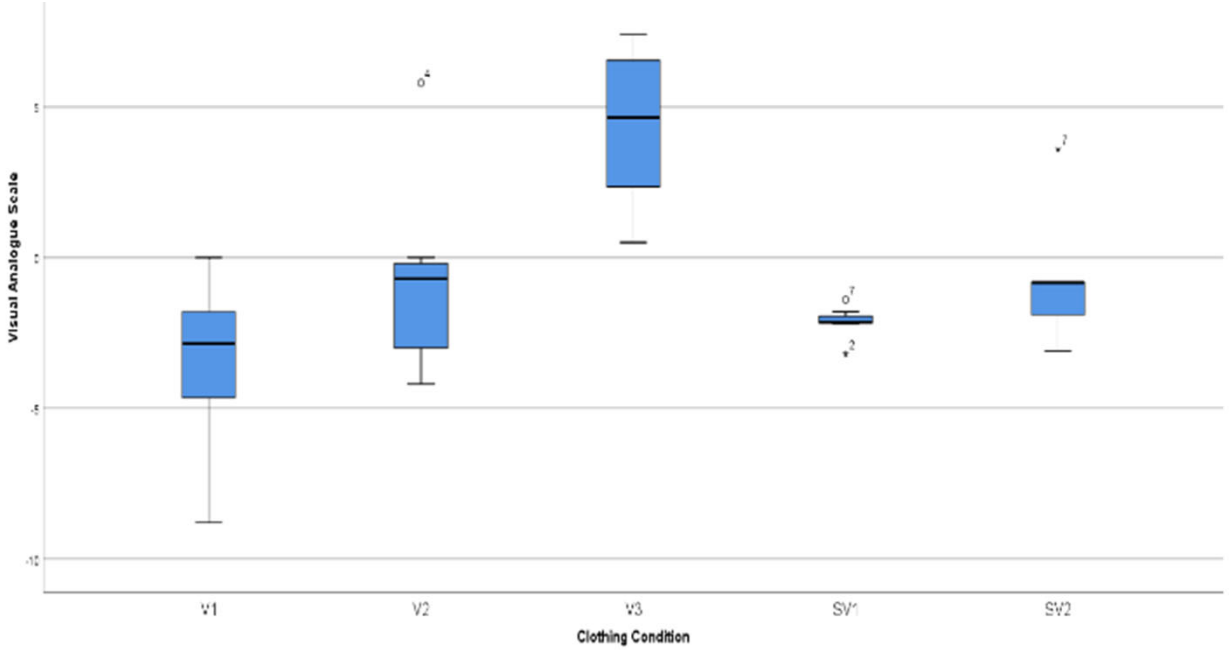
Subjective results of the FMS when compared to station wear



Orr R, Simas V, Canetti E, Schram B. (2019) Impact of Various Clothing Variations on Firefighter Mobility: A Pilot Study. Safety 5(4), 78

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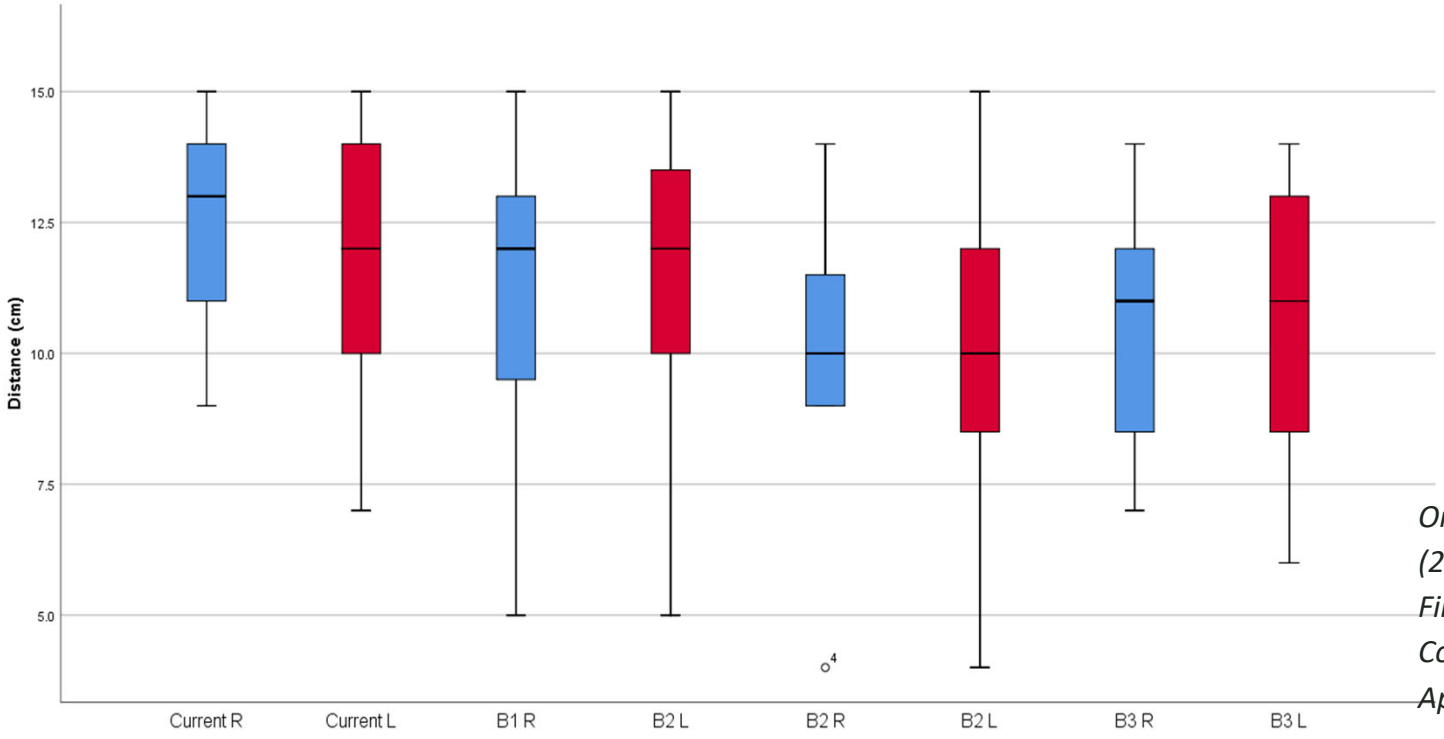

Orr, R., Schram, B., Simas, V., Maupin, D., & Canetti, E. (2019). Impact Of Various Clothing Ensembles On Firefighter. Bond University: Tactical Research Unit. Commissioned and funded by the Australian Defence Apparel.

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	MBA	LEBA
Deep squat	2.20 ± 0.79	2.50 ± 0.71
Hurdle step	1.80 ± 0.63	1.80 ± 0.79
Inline lunge	2.10 ± 0.74	2.70 ± 0.48 *
Shoulder mobility	1.40 ± 0.52	1.90 ± 0.57 ‡
Active straight leg raise	1.80 ± 0.79	2.30 ± 0.67
Trunk stability pushup	2.30 ± 0.82	2.60 ± 0.52
Rotary stability	1.80 ± 0.79	1.60 ± 0.84
Total	13.40 ± 2.17	15.40 ± 1.90 *

* significantly greater than with MBA vest ($p < 0.05$); ‡ $p = 0.059$.

Orr RM, Pope R, Schram B, Lyons K, Correa D, Tomes C, Hing W. Individual Light Armour Vest (ILAV) Report.

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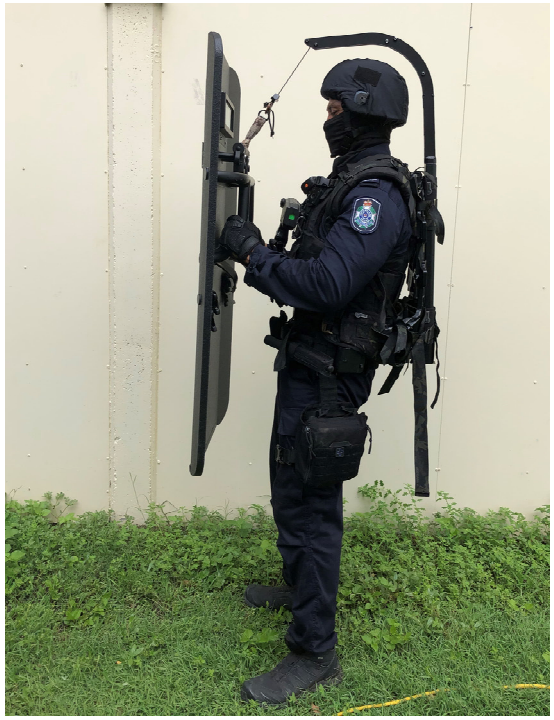

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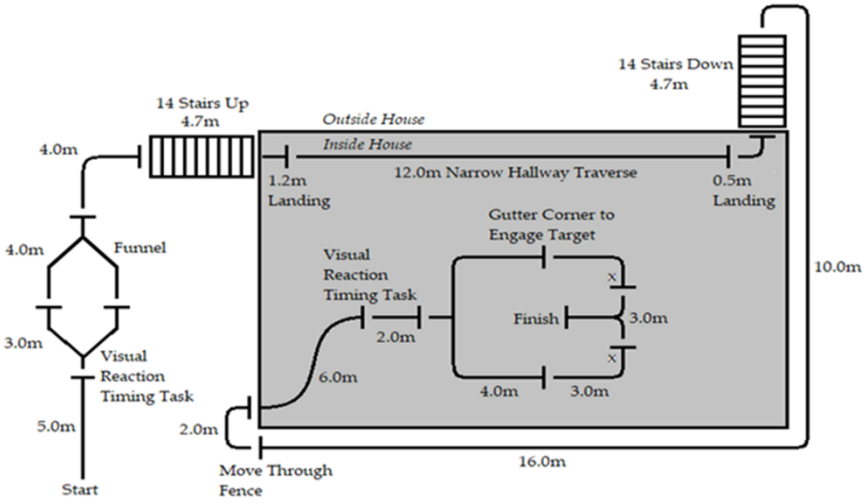


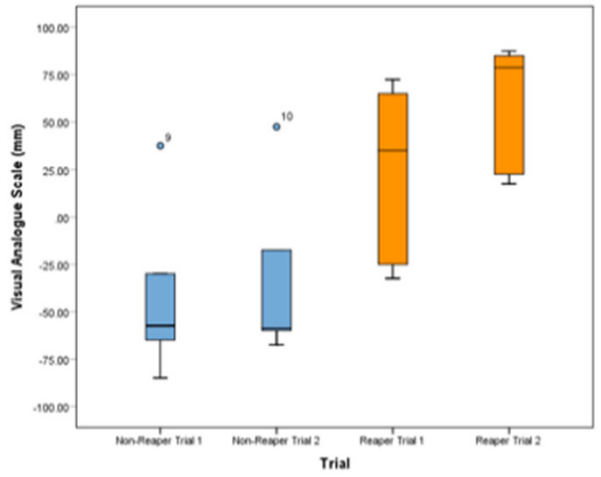
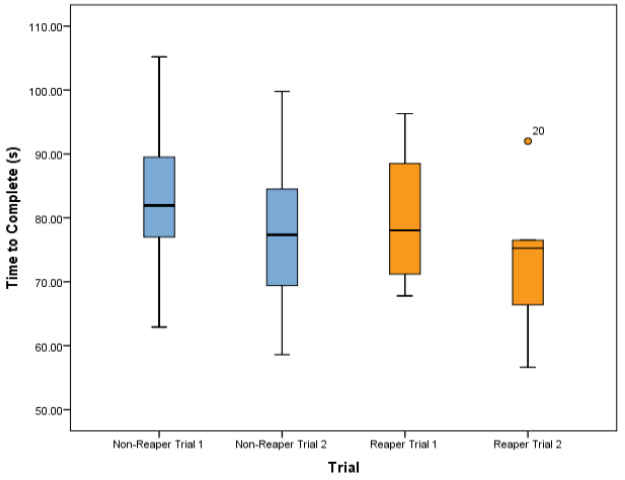


Figure 7. Boxplot diagram of SRG police VAS scores across Reaper and Non-Reaper trials 1 and 2.



Pham, C., Hamilton, T. Canetti, E., Schram. & Orr. R. (2020) The use of a load carriage assistive device on tactical police mobility and lethality: a prospective cohort study.

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Thank you